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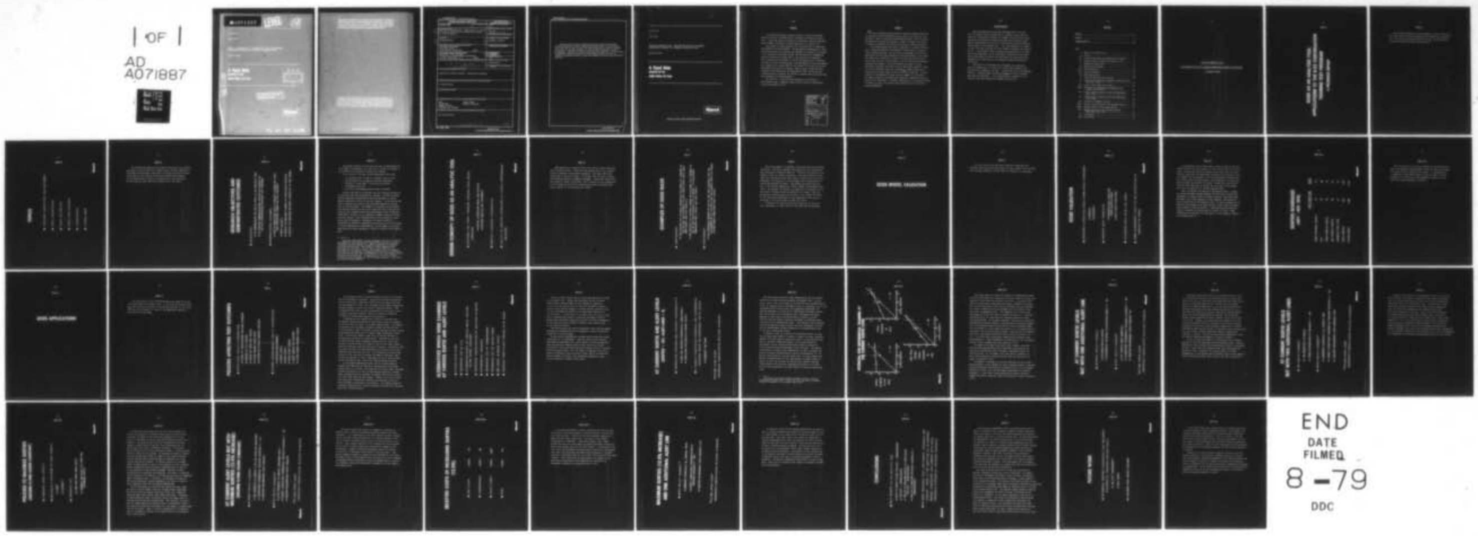

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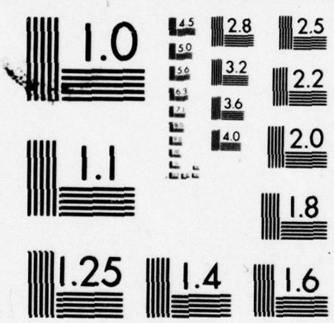

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July 1979

DOSS AS AN ANALYSIS TOOL: APPLICATIONS TO THE B-52 AIRCREW CONTINUATION TRAINING TEST PROGRAM--A PROGRESS REPORT

Richard Fallon

A Rand Note

prepared for the

United States Air Force

Rand
SANTA MONICA, CA. 90406

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Presents early results towards evaluating a rule-based system, called the Decision Oriented Scheduling System (DOSS), as an analysis tool. The DOSS is used to model SAC wing scheduling in order to examine the effects of several alternative policies and procedures on wing performance. This effort has provided estimates regarding the usefulness of DOSS for analyzing alternative scheduling policies, as well as identified possible payoffs in wing performance resulting from alternative policies.

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PREFACE

This Rand Note presents interim results of research performed under the Project AIR FORCE project "Scheduling and Resource Allocation." This work involves evaluating the Decision Oriented Scheduling System (DOSS), developed in earlier Rand work, as a policy tool.

The project is being conducted for the Directorate of Operations and Readiness, Hq USAF (AF/XOO). Because DOSS was developed for operating flying wings, the Strategic Air Command was informed of the intent of the research to ascertain whether SAC had particular command-wide resource allocation problems that it was interested in examining. After discussions with members of the Hq SAC senior staff, including the Chief of Staff, DCS/Operations, and DCS/Logistics, Rand team members were requested to evaluate DOSS in the context of the new B-52 Aircrew Continuation Training Test Program. DOSS is used to model SAC wing scheduling (both operations and maintenance) under the new aircrew training program to examine the effects of several alternative policies and procedures on wing performance.

The contents of this note were presented as a briefing to Major General Jack L. Watkins, Deputy Chief of Staff for Operations, at Hq SAC on March 28, 1979.

SUMMARY

This note presents early results of research towards evaluating the Decision Oriented Scheduling System (DOSS) as an analysis tool. The DOSS is used to model SAC wing scheduling under the B-52 Aircrew Continuation Training Test Program, in order to examine the effects of several alternative policies and procedures on wing performance.

It was demonstrated that DOSS is adaptable to a widely different set of rules and policies, and provides a valid model of a typical wing's scheduling rules. In the course of examining the effects of alternative policies and procedures on wing performance it was found that additional capability in terms of aircrew and aircraft availability may exist at the test-wings of the B-52 Aircrew Continuation Training Test Program. The note describes the extent of this additional capability and shows how such additional capability could be used for increased alert and training. A complete analysis of these policy options, however, has not yet been conducted. The note focuses on the analysis of these options primarily to illustrate the power of DOSS for estimating any additional capability that may exist at the test-wings. A further rounding-out of the analysis would be needed, in order to provide a more complete view of the policy options themselves.

ACKNOWLEDGMENTS

This work might never have been undertaken had it not been for the insight of Major General Jack L. Watkins, Deputy Chief of Staff for Operations, Strategic Air Command, that the B-52 Aircrew Continuation Training Test Program provided a good context within which to investigate the utility of the Decision Oriented Scheduling System (DOSS) as an analysis tool. I am also grateful to a number of staff officers at Hq SAC for their support throughout the research effort. I particularly wish to express my appreciation to the many SAC officers and NCOs of the 416th BMW at Griffiss Air Force Base and the 92nd BMW at Fairchild Air Force Base, who spent many hours explaining the complexities of scheduling flying and maintenance activities.

I am grateful to numerous Rand colleagues, but especially Morton B. Berman and I. K. Cohen, for their patient guidance and constructive criticisms of my work. I would also like to acknowledge Richard J. Hillestad whose earlier developmental work of the DOSS made this work possible. I also thank Marsha D. Hopwood for her careful review and constructive comments of this note.

CONTENTS

DOSS AS AN ANALYSIS TOOL:

APPLICATIONS TO THE B-52 AIRCREW CONTINUATION TRAINING TEST PROGRAM

A PROGRESS REPORT

CHART 1

DOSS AS AN ANALYSIS TOOL: APPLICATIONS TO THE B-52 CONTINUATION TRAINING TEST PROGRAM

A PROGRESS REPORT

CHART I

This briefing describes the work completed to date toward evaluating the Decision Oriented Scheduling System (DOSS) as an analysis tool. This work was performed under the Project AIR FORCE project entitled "Scheduling and Resource Allocation."

CHART II

TOPICS

- RESEARCH OBJECTIVES AND OUTCOMES
- DOSS DESCRIPTION
- DOSS VALIDATION
- DOSS APPLICATIONS
- CONCLUSIONS
- FUTURE WORK

Rand

CHART II

The briefing will describe the research objectives of the project; the design concept of DOSS as an analysis tool; the work completed in developing and validating a DOSS model of aircrew and aircraft scheduling under the B-52 Aircrew Continuation Training Test Program; several applications of DOSS as an analysis tool; our conclusions derived from this work; and work we plan to do in the future.

CHART III

RESEARCH OBJECTIVES AND DEMONSTRATED OUTCOMES

- OBJECTIVES
  - TO DEMONSTRATE THE USE OF DOSS AS AN ANALYSIS TOOL
  - TO PROVIDE DEMONSTRATIONS WITHIN THE CONTEXT OF THE B-52 CONTINUATION TRAINING TEST PROGRAM
- DEMONSTRATED OUTCOMES:
  - EASE IN MODIFYING DOSS TO REFLECT SCHEDULING RULES AND PROCEDURES UNDER THE TEST PROGRAM
  - DOSS VALIDITY
  - ABILITY TO MEASURE PAYOFFS OF PARTICULAR POLICIES
  - ABILITY TO MEASURE RESIDUAL CAPABILITY AT TEST WINGS

Rand

CHART III

Our primary objective in this work has been to demonstrate the use of DOSS as an analysis tool, and to do so within the context of the B-52 Aircrew Continuation Training Test Program.

In the course of the work we have demonstrated that DOSS:

- o Is relatively easy to adapt to different sets of rules and procedures for aircrew and aircraft scheduling;
- o Provides a "valid model"* of aircrew and aircraft scheduling rules; and
- o Is useful in performing several types of analyses.

We have used DOSS as an analysis tool in estimating the payoffs of particular policies affecting test outcomes. We have also used DOSS for comparing combinations of policies designed to achieve similar objectives to those of the test program. In this way we were able to estimate the extent of any additional capability that may exist at the test-wings. For example, we considered policy options that allowed even more sorties to be flown than are currently flown under the test program, while still maintaining current flying hour allocations. We have not yet conducted a complete analysis of these policies, however. This briefing focuses on the analysis of these policy options primarily to illustrate the power of DOSS for estimating any additional capability that may exist at the test-wings. A further rounding-out of the analysis would be needed if one found some particular policy appealing, in order to provide a more complete view.

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*The term "valid model" is used throughout this Note to indicate that schedules produced with DOSS, using rules extracted from wing schedulers, are very similar on a number of measures to schedules actually produced at the wing (details of these comparisons are given later in the Note). On the basis of this similarity we concluded that the DOSS provides a valid model of what is scheduled at a wing for the purposes of examining alternative rules and policies. This Note does not deal with the differences that exist between what is scheduled and accomplished. An analysis of the effects of these differences would be needed in a more complete analysis of the policy alternatives being examined.

CHART IV

DESIGN CONCEPT OF DOSS AS AN ANALYTIC TOOL

- CAPTURES THE "REAL" PROBLEM THROUGH RULE-BASED LANGUAGE
  - ACTUAL SCHEDULING RULES AND POLICIES
  - FLEXIBLE ENGLISH-LIKE STATEMENTS
- RAPIDLY ASSESSES ALTERNATIVES
- ABILITY TO PROVIDE OPERATIONALLY USEFUL PERFORMANCE MEASURES

CHART IV

DOSS operates on a series of rules that reflect actual scheduling rules and SAC policies. These rules are communicated to the computer system in flexible, English-like statements. This makes DOSS relatively easy to use and to adapt. The analyst does not need to master sophisticated computer programming languages. Furthermore, DOSS allows the analyst to change rules easily, and to rapidly see the consequences of rule changes in the form of operationally useful performance measures, such as the total sorties that result.

CHART V

EXAMPLES OF DOSS RULES

- CONSTRAINTS
  - THE ACTIVITY FLY (FLYING) CANNOT BE ASSIGNED TO A MEMBER OF THE SET B52 (B52 AIRCRAFT) IF DAYS.UNTIL.ALERT (DAYS UNTIL NEXT ALERT) ARE LESS THAN 2.5;
  - THE ACTIVITY FLY (FLYING) CANNOT BE ASSIGNED TO A MEMBER OF THE SET B52 (B52 AIRCRAFT) IF FLY.HOURS. (FLYING HOURS REMAINING UNTIL PHASE) ARE LESS THAN 0;
- PREFERENCES
  - THE PREFERRED MEMBER OF THE SET B52 (B52 AIRCRAFT) FOR THE ASSIGNMENT OF FLY (FLYING) HAS THE HIGHEST TOTAL FLY.HOURS. (FLYING HOURS REMAINING UNTIL PHASE);

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CHART V

DOSS was designed to accommodate both maintenance and operations scheduling. This chart displays some examples of actual DOSS rules that maintenance schedulers adhere to. The first rule depicted is an example of what is called a constraint. This rule prohibits an aircraft that is going on alert from flying 2.5 days prior to the alert changeover; the purpose is to allow enough time for maintenance to prepare the aircraft for alert. The analyst can easily vary the rule to see how any changes will affect a number of performance measures. For example, the analyst can change the 2.5 parameter to 1.0, and thereby increase aircraft availability for flying. Then, by generating a schedule using the new rule, he can measure the effect of this increased availability on such measures as total sorties generated, or the total number of BPOs that result.

Preferences for choosing particular resources that meet the many constraints are other types of rules that DOSS incorporates.

CHART VI

DOSS MODEL VALIDATION

CHART VI

Our first task in this work was to develop a DOSS model for scheduling aircrews and aircraft under the test program, and to validate that the model adequately reflects what is scheduled at a test-wing.

CHART VII

DOSS VALIDATION

- OBTAINED SCHEDULING RULES FROM WING SCHEDULERS
  - GRIFFISS
  - FAIRCHILD
- ADAPTED DOSS PROCESSES
  - PRODUCED DOSS BASE-LINE FROM GRIFFISS RULES
  - DOSS EASILY ADAPTABLE
- VALIDATED DOSS BASE-LINE MODEL
- SOME DIFFERENCES EXIST IN THE ALLOCATION OF SORTIES TO CREWS

CHART VII

In developing a set of DOSS rules to model aircrew and aircraft scheduling under the test program, we made several trips to both test-wings. During these visits we learned a great deal about the rules that both operations and maintenance schedulers have adopted in order to implement the test program. With this information we developed a set of DOSS rules, called processes, which scheduled on a day-to-day basis aircrews and aircraft for flying. We used the rules derived from the 416th Bomb Wing at Griffiss Air Force Base in developing what will be referred to as the DOSS baseline model.

Next, we compared the outputs of the baseline model, covering the period September through November 1978, with what actually was scheduled on a weekly basis at Griffiss during the same time period. We found a very close similarity on most measures, the details of which are depicted on the following chart. We thus concluded, on the basis of this evidence, that DOSS provides a valid model for analyzing alternative rules and policies. Some differences did show up, however, regarding the distribution of sorties to crews. These differences are important for some aspects of the analysis, and will be discussed later on.

CHART VIII

SORTIES SCHEDULED
(SEPT. - NOV. 1978)

	DOSS BASE-LINE	WING
EVENT TRAINING SORTIES	79	76
CSS	47	46
NIGHT PROFILE SORTIES	58	57
DAY PROFILE SORTIES	44	47
SEPARATE PILOT PROS	13	13
TOTAL SORTIES	241	239
FLYING HOURS	1,383	1,377

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CHART VIII

This chart depicts the sorties scheduled by the DOSS baseline model for September through November 1978, and compares them with the sorties actually scheduled at Griffiss. It essentially is a comparison of what DOSS scheduled, using the same rules that schedulers at Griffiss said they attempted to adhere to, with what was actually scheduled at Griffiss.

CHART IX

DOSS APPLICATIONS

CHART IX

The next section of the briefing discusses two types of applications using DOSS as an analysis tool. In the first application, DOSS was used to measure the payoffs of particular policies; in the second, DOSS was used to measure th. extent of any additional capability existing at the test-wings.

CHART X

POLICIES AFFECTING TEST OUTCOMES

- WING-LEVEL POLICY ALTERNATIVES
  - EXTENT OF CONSOLIDATED MISSION PLANNING
  - NUMBER OF CSS SORTIES
  - LENGTH OF CREW REST PERIOD
  - FLYING BEFORE/AFTER ALERT
  - PATTERN OF FLYING/TURNING AIRCRAFT
  - ⋮
- HIGHER HEADQUARTERS POLICY ALTERNATIVES
  - TRAINING REQUIREMENTS
  - SORTIE LEVELS
  - ALERT LEVELS
  - THRU-FLIGHT PERIOD
  - ALERT LENGTH FOR AIRCRAFT
  - FLYING HOURS BETWEEN PHASES
  - ⋮

Rand

CHART X

Two different levels of policy alternatives affect test outcomes and wing performance in general: wing-level and higher-headquarters policy alternatives. Wing-level policies are those which the wing has some measure of control over, although clearly higher headquarters provides guidance on nearly all types of wing alternatives. DOSS incorporates both types of policy alternatives in the form of rules in order to generate schedules, and thus is useful in analyzing the affects of alternative policies at both levels.

To demonstrate the capabilities of DOSS as an analysis tool, we analyzed several alternatives at both policy levels and compared the results with the outputs of the DOSS baseline model. For example, at the wing level, one major difference between the Fairchild and Griffiss wings is that, at Griffiss, mission planning for night sorties is performed four hours prior to takeoff using "preplanned" mission data. At Fairchild, however, eight hours of mission planning is performed the day prior to a night sortie. With DOSS we were able to assess that by using "preplanned" mission data for their night sorties, Griffiss was able to achieve 14 percent more night sorties than they otherwise would have been able to achieve. In addition, they were able to achieve a better distribution of sorties to crews than otherwise would have been the case. The criterion for distributing sorties in this case was to equalize the number of different types of sorties allocated to crews. Both gains are due to the increased aircrew availability that results from reduced mission planning.

At the higher-headquarters level, one of the many things we examined with DOSS were the effects of increasing the thru-flight period from 48 to 72 hours. We found that the 72-hour policy increased airframe availability, as well as scheduling flexibility, although these advantages were not necessary to generate the level of sorties that were flown under the test program. However, the 72-hour policy did bring about a significant reduction in maintenance costs on a selected number of maintenance cost measures. For example, BPOs and preflight inspections were reduced 23 percent from what they would have been under a 48-hour policy.

CHART XI

ALTERNATIVES WHICH WERE EXAMINED AT VARIOUS SORTIE AND ALERT LEVELS

- FLYING AFTER ALERT
- INCREASED USE OF CSS
- ALTERNATIVE MIXES OF SORTIES WHILE HOLDING FLYING HOURS CONSTANT
- INCREASED CONSOLIDATION OF MISSION PLANNING
- DIFFERENTIAL TRAINING
- INCREASED USE OF TURNAROUNDS
- INCREASED USE OF QUICK-TURNS
- 200 HOURS BETWEEN PHASE
- INCREASE THRU-FLIGHT PERIOD TO 96 HOURS

Rand

CHART XI

The next several charts involve a different application of DOSS as an analysis tool. Having been impressed with the increased effectiveness achieved under the test program, at apparently little or no increase in cost, we wanted to use DOSS to analyze various policy options designed to achieve similar objectives, and in this way measure the extent of any additional capability at the test-wings. It should again be stressed that the policy options that we analyzed were chosen to illustrate the power of DOSS to measure that additional capability, and that a further rounding-out of the analysis would be needed to provide a more complete view of any particular policy.

This chart depicts the policy alternatives (both wing and higher-headquarters alternatives) that we examined to measure additional capability at the test-wings.

We made several examinations, varying these alternatives either individually or in combination. The next several charts discuss some general conclusions from a small subset of these examinations. These alternatives primarily affect either aircrew or aircraft availability, and as such have different relative effects at various sortie and alert levels. For this reason we examined these alternatives at different sortie and alert levels, and in so doing were able to measure the extent of any additional capability, given current resources to achieve these levels.

CHART XII

AT CURRENT SORTIE AND ALERT LEVELS
(SORTIES = 241; ALERT-LINES = 4)

- INCREASING AIRCREW AND AIRCRAFT AVAILABILITY★
  - DOES NOT IMPROVE PERFORMANCE SIGNIFICANTLY
  - SUFFICIENT AVAILABILITY ALREADY EXISTS
- A HIGHLY SIGNIFICANT POTENTIAL FOR DIFFERENTIAL TRAINING BASED ON EXPERIENCE LEVELS EXISTS
  - CURRENTLY NOT DONE

★FLYING AFTER ALERT
INCREASED CONSOLIDATED MISSION PLANNING

CHART XII

The first sortie and alert level considered was the one actually achieved at Griffiss between September and November 1978. At this level, when we made rule changes to the baseline model designed specifically to increase aircrew availability (that is, allowing a crew to fly the Monday after its alert duty, and increasing consolidation of mission planning*), we found that no significant performance improvement was achieved over the baseline case. Performance was being measured in this case by the distribution of sorties to crews, with the objective being to equalize the number of different types of sorties to all mission-ready crews. This indicates that sufficient aircrew availability already existed, and that increasing it further did not significantly increase flexibility in choosing which crews to fly over a three-month period.

In addition, when the criterion for allocating sorties to crews was no longer equal numbers of sorties to crews, but rather different numbers of sorties based on experience levels, we find that DOSS was able to provide a significant amount of such differentiation. Furthermore, we see no such differentiation based on experience levels currently being accomplished at the test-wings. The measure of experience we chose in this examination, in order to measure the extent of possible differentiation, was the SAC-designated "S", "E", and "R" crew levels for a mission-ready crew. The logic behind this method of differentiation or any other method you might choose, of course, is that for any level of sorties flown, greater training effectiveness can be achieved by giving more sorties to the crews with the least experience, and fewer sorties to the more experienced crews.

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*The term "consolidated mission planning" refers to the use of preplanned mission data to allow for only four hours of mission planning as opposed to the standard eight hours.

CHART XIII

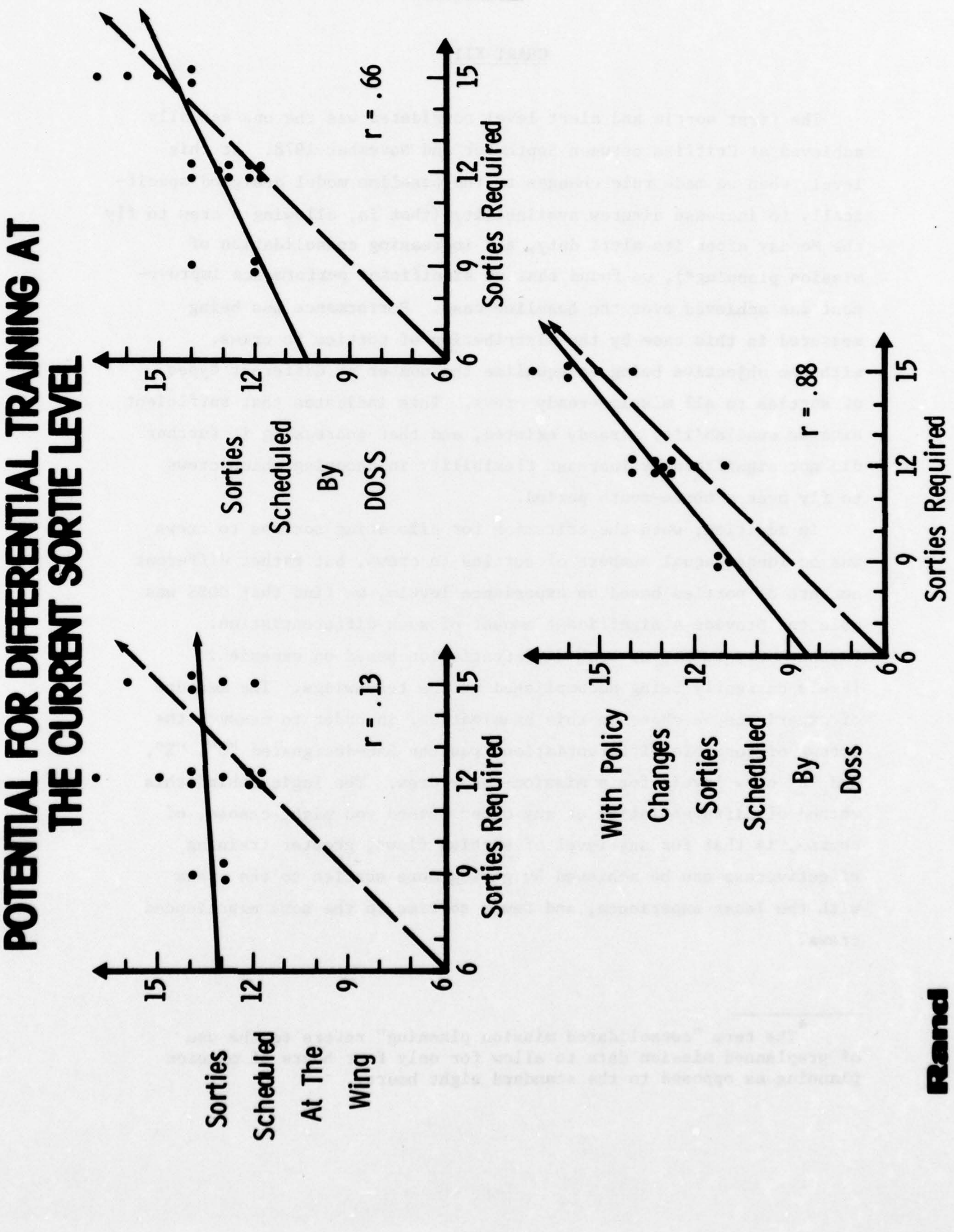
POTENTIAL FOR DIFFERENTIAL TRAINING AT
THE CURRENT SORTIE LEVEL
Sorties
Scheduled
At The
Wing
15
12
9
6
9
12
15
Sorties Required
r = .13
Sorties
Scheduled
By
DOSS
15
12
9
6
9
12
15
Sorties Required
r = .66
With Policy
Changes
Sorties
Scheduled
By
Doss
15
12
9
6
9
12
15
Sorties Required
r = .88
Rand

CHART XIII

This chart depicts in detail the extent of differentiation based on total sorties that were scheduled at Griffiss, and sorties that were scheduled by DOSS under two different conditions. The graph in the upper left-hand corner shows what was actually scheduled at the wing. The vertical axis depicts total sorties scheduled, and the horizontal axis depicts different sortie requirements that were given to each crew based on experience level. (For example, the "S" crews had a requirement of 9, the "E" crews 12, and the "R" crews 15.) Each dot represents one of 17 crews that were available during the entire three-month period. As the graph indicates, crews were not allocated significantly different numbers of sorties based on experience levels. The ideal allocation would be such that all sorties scheduled would line up parallel to a line having unit slope (i.e., the dashed line in the graph). We see in this graph, however, that the sorties scheduled are more or less evenly distributed about a nearly horizontal line (i.e., the solid line in the graph), where sorties scheduled equal approximately 13. This relationship is reflected by a low correlation between sorties scheduled and those required (r=.13).

The graph in the upper right-hand corner, however, indicates that the DOSS baseline model, when instructed to differentiate on the basis of experience levels, achieved a significant amount of differentiation. In this graph we see that sorties scheduled are more closely aligned to sorties required, which is reflected by a higher correlation (r=.66).

Furthermore, the graph at the bottom indicates how much better differentiation is made possible by policy changes designed to increase aircrew availability (specifically, allowing a crew to fly the Monday following its alert duty, and increasing consolidation of mission planning). In this case, sorties scheduled are almost perfectly aligned with sorties required, which is reflected by a high correlation r=.88).

CHART XIV

AT CURRENT SORTIE LEVELS BUT WITH ONE ADDITIONAL ALERT LINE

- WITHOUT POLICY CHANGES
  - 6% REDUCTION IN SORTIES
  - DIFFERENTIAL TRAINING DISTRIBUTION WORSE (r = .28)
- WITH POLICY CHANGES★
  - ALL SORTIES WERE GENERATED
  - SIGNIFICANT DIFFERENTIAL TRAINING ACHIEVED (r = .96)
  - SELECTED MAINTENANCE COSTS REDUCED (7%)

★FLYING AFTER ALERT

INCREASED CONSOLIDATED MISSION PLANNING

CHART XIV

This chart depicts the effects of increasing the alert force by one additional alert-line (an increase from four aircrews and aircraft on alert to five) while still maintaining the same sortie level as in the DOSS baseline case. Without any rule changes made to the DOSS baseline model, we see that the increased alert severely constrains aircrew and airframe availability to fly, to the point that there is a 6 percent reduction in sorties coupled with a much poorer distribution of training. The correlation between sorties scheduled and those required in this case is only .28 (r=.28). However, with specific policy changes to increase aircrew availability (that is, allowing a crew to fly the Monday following its alert duty, and increasing consolidation of mission planning)the same level of sorties is scheduled as was scheduled with four alert-lines, a highly significant amount of differential training is achieved (r=.96), and some selected maintenance costs are reduced (BPOs and preflights are reduced 7 percent).

So far, we have only looked at a selected set of performance measures on both the operations and the maintenance side. Clearly, maintenance costs increase when an additional aircraft is maintained on alert. Also, there are probable morale costs associated with extra alert duty. Therefore, as stressed earlier, a further rounding-out of the analysis would be needed to gain a more complete view of this policy option, and of others that will be discussed.

CHART XV

AT CURRENT SORTIE LEVELS BUT WITH TWO ADDITIONAL ALERT LINES

- NO POLICY CHANGES
  - 17% REDUCTION IN SORTIES
  - POOR DISTRIBUTION OF TRAINING (r = -.02)
- WITH POLICY CHANGES*
  - GENERATES ESSENTIALLY ALL SORTIES (99%)
  - HIGHLY SIGNIFICANT DIFFERENTIAL TRAINING ACHIEVED (r = .86)
  - SELECTED MAINTENANCE COSTS REDUCED (15%)

*FLYING AFTER ALERT
INCREASED CONSOLIDATED MISSION PLANNING

Rand

CHART XV

Suspecting that additional wing capability exists, we next used DOSS to measure the effects of adding two alert-lines (an increase from four aircrews and aircraft to six) while still maintaining the same sortie level as in the baseline case. In this case, we find aircrew and aircraft availability even more severely constrained than they were when we added only one additional alert-line. Sorties are reduced by 17 percent. Also a very bad distribution of training-based experience levels results, with a correlation of sorties scheduled to those required of nearly zero, and, in fact, negative (r=-.02). We do find, however, with policies designed to increase aircrew availability (again, allowing a crew to fly the Monday following its alert duty, and increasing consolidation of mission planning), that even at this increased alert level, essentially all the sorties scheduled under the baseline case can still be scheduled, with significant differential training being possible as well (r=.86).

CHART XVI

POLICIES TO MAXIMIZE SORTIES
(HOLDING FLYING HOURS CONSTANT)

- INCREASE SHORT SORTIES
- MAINTAIN A MINIMUM OF LONG SORTIES
  - HHDM
  - DIVERSITY
- INCREASE CSS
  - TURN TWO FROM THREE INPUTS
  - GENERATE ONE NIGHT CSS FROM TWO AFTERNOON INPUTS

Rand

CHART XVI

In addition to increasing the alert force while holding the sortie level constant, we analyzed another policy option in order to measure the extent of any additional capability at the test-wings: we increased the sortie level while holding the alert force constant. This chart depicts the policy alternatives that were adopted to achieve what is referred to as the maximum level of sorties given the current flying-hour allocation. The various policy options are essentially extensions of what is currently being tried out under the test program. We increased the number of shorter five-hour sorties and reduced the number of the longer seven-hour sorties from the levels scheduled under the baseline case, while holding flying hours constant. We further allowed for a minimum number of long sorties to remain in the schedule in order to fulfill higher headquarters directed mission responsibilities, as well as for participation in the diversity program. When all of these alternatives are considered simultaneously, this leads to a possible sortie increase of 12.5 percent, or 30 sorties more than were scheduled under the baseline case. In addition, we increased the number of CSS sorties scheduled, in ways described on the chart, in order to keep maintenance costs from increasing significantly.

At both test-wings, we found that the typical five-hour sortie was able to provide similar levels of training items accomplished per sortie as did the typical seven-hour sortie, for a number of important items (such as B01s, R01s, N09s, N15s, E01s). Therefore, in substituting more short sorties for some of the longer ones, we increase both sorties and training items. This increase, of course, must be weighed against any possible losses in diversified training resulting from being more constrained as to the number of bombing sites that can be visited. Again, a further rounding-out of the analysis would be necessary to provide a more complete view of the effects of such a policy option.

CHART XVII

AT CURRENT ALERT LEVELS BUT WITH MAXIMUM SORTIES (12.5% INCREASE)

(HOLDING FLYING HOURS CONSTANT)

- ● WITHOUT POLICY CHANGES
  - 10% INCREASE IN SORTIES (2.5% LESS THAN THE MAXIMUM)
  - SIGNIFICANT DIFFERENTIAL TRAINING ACHIEVED (r = .61)
  - SELECTED MAINTENANCE COSTS REDUCED
- ● WITH POLICY CHANGES★
  - 12.5% INCREASE IN SORTIES (MAXIMUM LEVEL)
  - HIGHLY SIGNIFICANT DIFFERENTIAL TRAINING ACHIEVED (r = .93)
  - SELECTED MAINTENANCE COSTS REDUCED

★FLYING AFTER ALERT

INCREASED CONSOLIDATED MISSION PLANNING

Rand

CHART XVII

This chart depicts the effects of attempting to achieve the maximum level of sorties by adopting the policy options previously discussed. It is interesting to note that without any policy changes made to increase aircrew availability, a 10 percent increase in the sortie level was scheduled given current aircrew and aircraft availability. Also, enough flexibility still prevailed at this increased sortie level to provide significant differential training (r=.61). Furthermore, a number of selected maintenance costs were reduced, a point that is discussed in more detail on the next chart. With policy chanages designed to increase aircrew availability (as before, allowing a crew to fly the Monday after its alert duty, and increasing consolidated mission planning), we find the maximum level of sorties is achievable, along with differential training (r=.93) and reduced maintenance costs.

CHART XVIII

SELECTED COSTS OF INCREASING SORTIES (12.5%)

● PRE-FLIGHT	DOWN	5%
● TURNAROUNDS	DOWN	6%
● QUICK-TURNS	DOWN	100%
● BPOs	DOWN	5%

Rand

CHART XVIII

The selected maintenance costs we considered are those incurred by activities that use maintenance resources directly involved with the flying activity. These activities are preflight inspections, BPOs, and thru-flight inspections. Two types of thru-flight inspections are considered: turnarounds (greater than 24-hour ground time since the last flight) and quick-turnarounds (between 12 and 24 hours ground time since the last flight). As depicted on this chart, all such maintenance activities were reduced from the baseline case, under the previously described policies designed to increase sorties to the maximum level of 12.5 percent while holding flying hours constant. These reductions were made without any changes to the DOSS baseline maintenance rules regarding the preferences of maintenance schedulers in choosing aircraft to fly.

CHART XIX

MAXIMUM SORTIES (12.5% INCREASE) AND ONE ADDITIONAL ALERT LINE

- WITH POLICY CHANGES ★
  - GENERATE ESSENTIALLY ALL SORTIES (99+%)
  - HIGHLY SIGNIFICANT DIFFERENTIATION OF TRAINING ACHIEVED (r = .89)
  - SELECTED MAINTENANCE COSTS REDUCED (7%)

★FLYING AFTER ALERT

INCREASED CONSOLIDATED MISSION PLANNING

Rand

CHART XIX

In addition to what we have already demonstrated, we wanted to find out whether existing wing capability was great enough not only to achieve higher sortie levels but to increase the alert force at the same time. This chart depicts the results of attempting to achieve the maximum sortie level (by adopting the policy options shown on Chart XVI) with five instead of four aircrews and aircraft on alert, as was previously attempted. We find that this sortie and alert level was achievable, under policy changes designed to increase aircrew availability. (As before, the rule changes made to the baseline case were to allow flying by an aircrew the Monday following its alert duty, and to increase consolidated mission planning.) Furthermore, significant differential training ($r=.89$) and a reduction of 7 percent in the number of preflights and BPOs were also scheduled.

CHART XX

CONCLUSIONS

- DOSS WORTHY AS AN ANALYSIS TOOL
  - EASY TO ADAPT TO NEW POLICIES – DEMONSTRATED
  - VALIDITY – DEMONSTRATED
  - ABILITY TO MEASURE EFFECTS OF PARTICULAR POLICIES – DEMONSTRATED
  - ABILITY TO MEASURE RESIDUAL CAPABILITY – DEMONSTRATED
- ON MANY MEASURES DOSS AND MANUAL SCHEDULES ARE SIMILAR. THERE IS THE QUESTION AS TO WHETHER MANUAL SCHEDULERS CAN COMPETE WITH DOSS PRODUCED DIFFERENTIAL TRAINING SCHEDULES

Rand

CHART XX

From the work accomplished to date, in which we have used the DOSS as an analysis tool to examine a number of policy alternatives within the context of the B-52 Continuation Training Test Program, we conclude that DOSS is a worthy analysis tool. We have demonstrated its adaptability to a widely different set of rules and policies, its validity as a model of a typical wing's scheduling rules and policies, and its ability to provide several types of useful analyses of both wing as well as higher-headquarters policy alternatives. Furthermore, while we have considered a number of policy options designed to measure, with DOSS, the extent of any additional capability that may exist at the test-wings, several other options for using that capability can be analyzed. For instance, without holding flying hours constant, one could examine the total number of sorties that are possible at a typical SAC wing, given constraints only on aircrew and aircraft availability.

One issue on which we have yet to draw any conclusions is whether schedulers, without any computer assistance, can achieve the kind of performance that DOSS is able to achieve, specifically with regard to providing differential training. We have observed in the validation process, for instance, that DOSS provided a better distribution of training, based upon the objective expressed by operations schedulers of allocating equal numbers of different types of sorties to all mission-ready crews. The question remains whether schedulers really were attempting to achieve this type of distribution and found it too difficult, or were simply adhering to other rules in distributing sorties. The concept of differential training based on a measure of experience further complicates scheduling, and hence the question arises: Can schedulers cope with this added level of difficulty and provide the extent of differential training shown possible with DOSS? We plan to address this question in our future work, which is described in more detail on the next chart.

CHART XXI

FUTURE WORK

- DETERMINE WHETHER SCHEDULERS CAN IMPLEMENT DIFFERENTIAL TRAINING RELATED RULES
  - LAB TYPE "EXPERIMENTS"
  - REAL WORLD
- DOCUMENT TOTAL PROJECT OUTCOMES

CHART XXI

In our future work, then, we would like to determine the extent to which schedulers, without computer assistance, can implement differential training-related rules and in general exploit additional aircraft and aircrew availability. To do so, we plan in the very short term to perform some off-line, lab-type "experiments" in which we interact with the schedulers at a low level--about the same level as we have in the past. These off-line "experiments" would essentially be some small set of scheduling exercises we would ask the schedulers to perform.

Finally, we of course intend to publish a report on the total project outcomes, at the currently scheduled close of the project. This would include a detailed documentation of the DOSS processes used in the analysis, as well as a complete description of how DOSS was used as an analysis tool and what we were able to demonstrate regarding its capabilities. At that time we will also provide an analysis, more complete than the one we have accomplished to date, of the specific policy alternatives examined with DOSS.